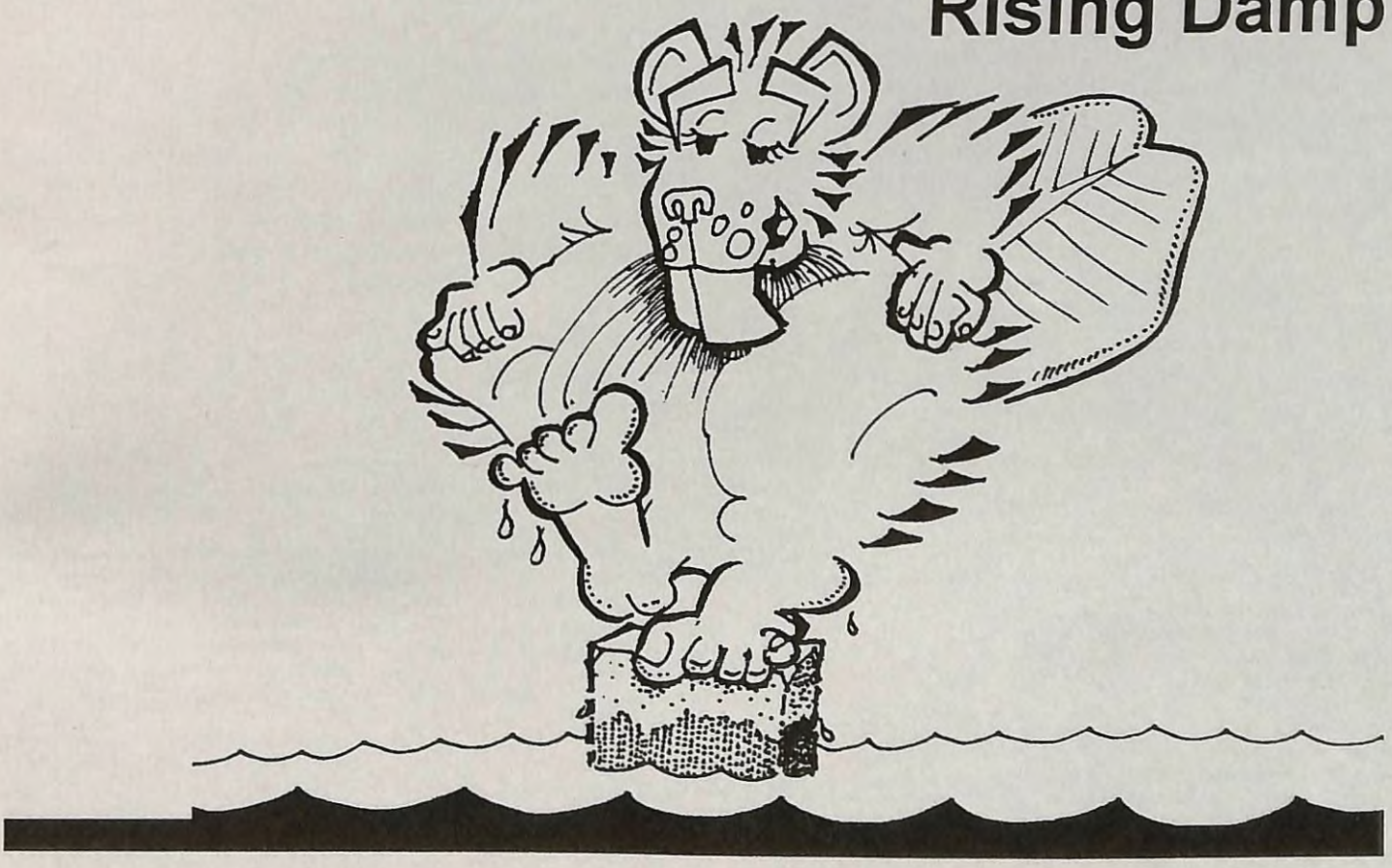
No. 113 November 2003

solplan review

the independent journal of energy conservation, building science & construction practice

Contents

Rising Damp



From the Editor

The current construction boom is challenging our industry. The escalating cost of materials is a concern, as is the insurance crisis. However, the more significant issue is the shortage of skilled labour.

The skills shortage is going to be with us for some time. A number of social currents are contributing to this. We have the changing demographic profile of the population. An aging population and lower birthrates mean that the number of young people entering the workforce is less than the number retiring from it, so that the total available pool of workers is decreasing. As a country of immigrants, we have relied on immigration in the past to make up for labour shortages, since we've encouraged the young and well educated to come here.

Disregarding the morality of such a policy, this is not a sustainable way of dealing with the labour problem. Encouraging immigration does nothing for many regions in the world that are in desperate need of a local trained workforce. They need all the help they can get without us sourcing their best and brightest for our own needs. Depleting the developing world of its talent does nothing for global stability as these economies languish. Recent events may be a taste of more to come, as frustrations well up.

We must look at our own resources. Here the picture is not bright. We've created a society that places high status on white-collar occupations. Office-based high tech and paper shuffling are high prestige activities. Productive occupations where people get their hands dirty, referred to as blue collar, are given lower status. Too often they are considered occupations of last resort for those that can't go to university.

As a society we don't seem to give tradespeople the same respect we do the lowliest computer operator or sales clerk. Yet the qualified trades person is much more valuable to society than paper shuffling clerks. We must find a way to give back prestige and standing to those in the trades who, in the end, are responsible for installing, building or repairing our infrastructure. It's not going to be done by someone on the other side of the world, working for a pittance.

The low esteem given to trades is evident in the inadequate training opportunities for those that do express an interest in them. Here in BC, there has been recognition that we need to review and redefine training opportunities for trades. Even so, apprenticeship programs were cut before alternative programs were in place, with the result that for a couple of years there will be confusion. High school graduates who express an interest don't have a clear direction in which to turn or courses to take.

We need to look at ways to change building practices. Because we don't have the numbers of young available to learn the trades, even if they were interested, perhaps it is time to look at ways to improve productivity with the limited labour pool we do have. Scandinavia went through a similar situation after the Second World War, with the result that now most of housing there is built in factories. Builders on the site assemble and hook up pre- or semi-finished components, rather than starting from scratch with stacks of lumber.

Manufactured housing components can be assembled with better quality control in a climate controlled environment and by labour with more limited skills. This would not be the total answer to labour shortages, but it would be one way of dealing with the problem. We have been moving in this direction, but ever so slowly. Perhaps we need to take a more aggressive look at our construction practices.

Richard Kadulski,
Editor

solplan review
the independent journal of energy conservation, building science & construction practice

Editor-Publisher: Richard Kadulski
Illustrations: Terry Lyster
Contributors: Rick fearn, Dara Bowser, Joe Waugh, Bob Switzer, Don Fugler, Rob Dumont, Michael Lacasse, Jim Stewart
ISSN: 0828-6574
Date of Issue: December 2003
SOLPLAN REVIEW is published 6 times per year by:
the drawing-room graphic services ltd.
Box 86627, North Vancouver, BC V7L 4L2
Tel: 604-689-1841 Fax: 604-689-1841
e-mail: solplan@direct.ca
Street address:
#204 - 1037 West Broadway
Vancouver, BC V6H 1E3

Canadian Publications Mail Product Sales Agreement No. 40013363
Postage paid in Vancouver, BC.

SUBSCRIPTIONS: In Canada 1 year $50.29 (incl GST) (NB, NS, NF $54.05 includes HST); 2 years $90.95 (incl GST) (NB, NS, NF $97.75 includes HST). USA and other foreign payable in US $ 1 year $54.00, 2 years $98.00.

CHANGE OF ADDRESS: include a mailing label or copy all information off label for faster, accurate processing.
CONTRIBUTIONS: Unsolicited contributions and manuscripts welcome. Include self-addressed pre-stamped mailer if return requested. Publisher not responsible for loss or damage of same.
While every effort is made to provide accurate and complete information, we do not warrant or guarantee the accuracy and completeness of such information.
ADVERTISING POLICY: Publisher's discretion in the acceptance of any advertisement. No endorsement is stated or implied by the publisher.
PRINTED IN CANADA
GST Registration: R105208805
SOLPLAN is a registered trademark of the Drawing-Room Graphic Services Ltd.

Rising Damp

Moisture in Concrete Foundation Walls

Basements are often damp and musty due to ground moisture from their cooler temperature, which raises the relative humidity. Foundations and basements can be major sources of moisture as ground water is sucked into the house. This is known as rising damp and is the major cause of chronic moisture and mould in basements.

Rising damp in concrete footings and walls is the wicking of water through concrete and its evaporation into the building. This leads to high humidity, and possibly to dampness and mould. Rising damp does not produce pools of water (as can be the case with a waterproofing failure in a concrete wall), but a constant musty smell that grows insidiously stronger when the concrete is exposed to more water.

Studies have shown that 40 litres of water per day can enter a house through its foundation. These are approximate quantities and depend on soil conditions, foundation construction details and temperatures. Older houses are more vulnerable to ground moisture getting in because of their poor foundation details, lack of ground cover or capillary breaks under the slab, or high water tables. This is especially the case in older houses built with no ground cover under the slab.

Although newer homes are built better, with a polyethylene sheet under the slab as standard construction practice, the footings are not sealed and can contribute to rising damp. Poor construction details and improper moisture management around the house offer large pools of water that can be a source of water to be sucked up.

We know that unless concrete is specially treated and waterproofed, it will allow moisture to pass through it. The question that comes up is just how much moisture can move through the concrete?

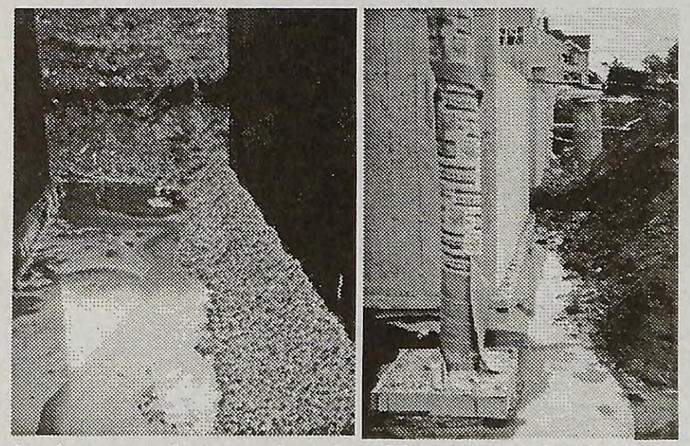
The industry has not examined the impact of water wicking in concrete. It is hard to calculate absolute quantities of moisture that can migrate through concrete because this depends on many variables including: the moisture content in the soil immediately adjacent to the building, the interior and exterior finishes, interior and exterior temperatures, and changes in moisture content.

A simple calculation for a well-built foundation wall suggests that about 1.3 g/m² per hour of water evaporates into the basement. This is based on an assumption that the basement air's relative humidity is at 60% at a temperature of 18°C (65°F) and mature concrete is at 100% RH just below the surface, and typical vapour permeability and vapour pressure gradients.

However, basement walls are generally not built perfectly. They have voids and cracks often created during the removal of forms and ties, and moisture management problems adjacent to the foundation, so the moisture flow would likely be higher.

Fab-Form Industries Ltd., a manufacturer of fabric concrete forming, recently did a test to measure the quantity of water that can be wicked up a concrete column. The test was done under the supervision of Phoenix Engineering Ltd., a geo technical engineer-

A typical 8" concrete basement wall has the capacity to wick 435 pounds of water every day. This is equivalent to about 200 litres of water



Standing water in footing trenches indicated footing is siting directly on hardpan, and the water that collects can be a source that can be wicked into the concrete, and become a potential source of moisture problems.

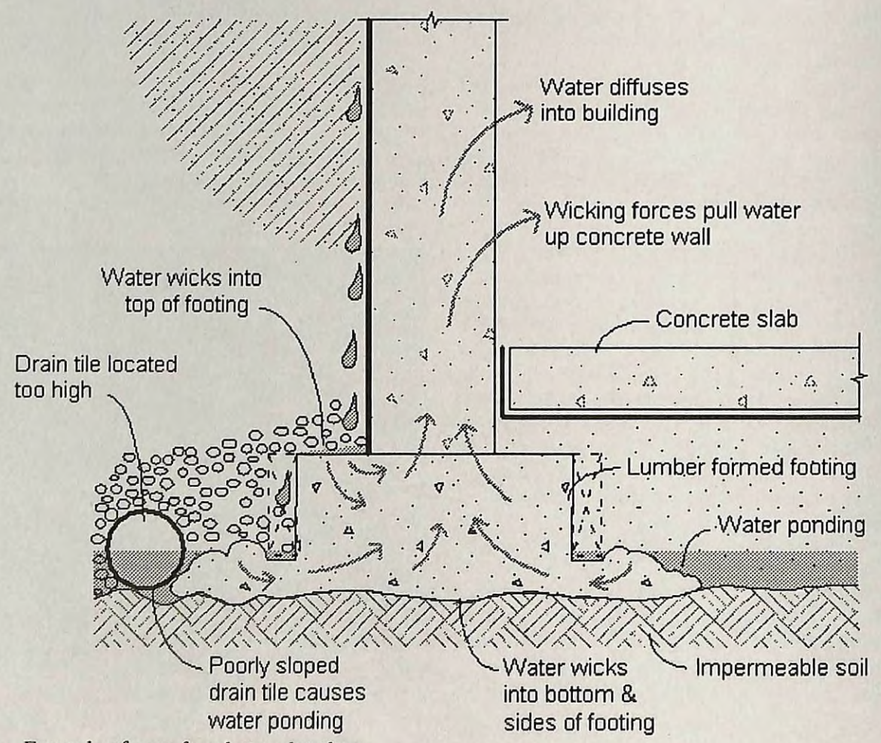
"Wicking" is the movement of water by forces of attraction (both capillary and chemical) between the water and the adsorbing material. These forces can be seen in a glass containing water, where the water's edge rises above its surface. If the diameter of the glass is reduced to the size of a thin straw, the force of attraction will become stronger than the gravitational force, causing the water to move up the straw.

ing firm specializing in the movement of water in soil structures.

A 5-½" diameter concrete column 28" high was set on end in a 5-gallon plastic bucket filled with 10-½" of water. To prevent water evaporation from the bucket itself, the top of the bucket around the column was sealed with a sheet of polyethylene plastic. So about 14" of the concrete above the sealed cover was exposed to the air, providing the surface area through which the concrete could dry.

After allowing five days for the water to a wick up the column, the bucket was weighed each morning for two weeks to measure the quantity of water wicked up through the concrete and evaporated into the air above. The test took place in early September, when the air was warm and dry. The bucket was exposed to reasonable ventilation but to no direct sunlight inside an ordinary office.

It was found that half a pound of water wicked up the column each day; this is the same as about ¼ litre of water. For a typical basement, which may have about 200 lineal feet of 8" thick concrete wall, the foundation has the capacity to wick about 435 pounds of water every day under conditions similar to the test.



Example of poor foundation detailing

Graphics courtesy of Fab-From Industries Ltd.

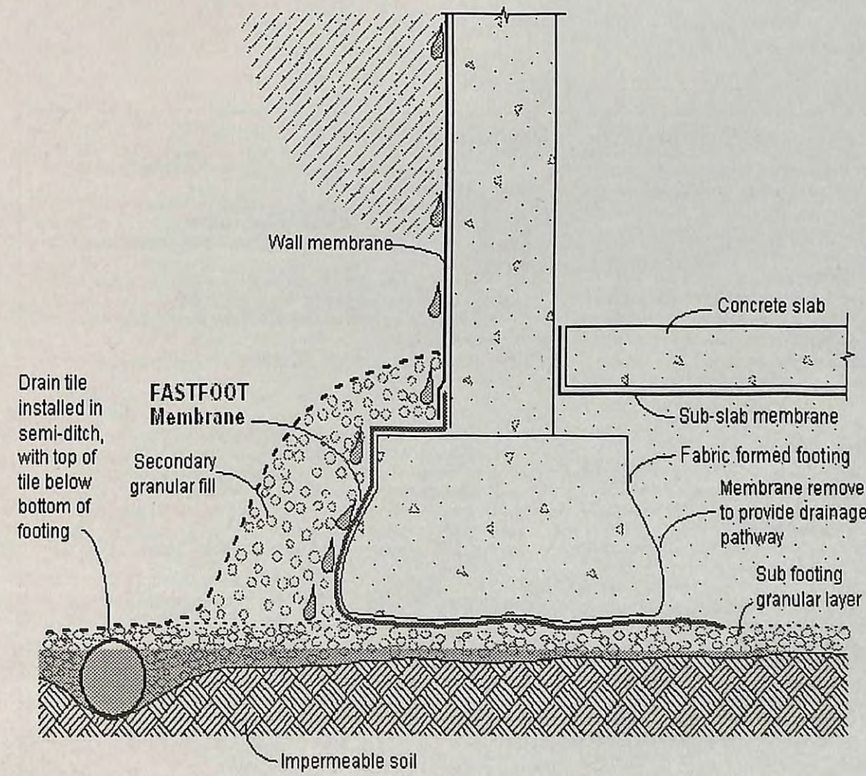
This is equivalent to about 200 litres of water each day.

Would a typical basement wick this amount of water? Only if there was water ponding surrounding the footing (which occurs with impervious soils not correctly drained), and where the interior walls were openly exposed to dry interior air. However, footings don't usually get a lot of attention and often sit in very wet soil at or below the water table, so there is a continuous water source to allow for upward capillary drive into the concrete.

What the test did show was that concrete has the capacity to wick up massive amounts of water. In most basements the quantity of water wicked through the foundation would be considerably less. Mould growth, however, requires a slow and persistent moisture source, which is exactly what rising damp is good at providing.

All concrete in contact with moisture laden soils must be protected from the moisture by a membrane (or other appropriate method). Since the maximum levels of moisture surrounding a basement are typically found at the bottom of the excavation where the concrete footing is located, the concrete footings must be protected from ground moisture. One cost-effective method of preventing rising damp in concrete footings is to use water-resistant membranes under the footings or as footing forms. ☼

For more information on the test:
FAB-FORM INDUSTRIES LTD.
Tel.: (604) 596-3278
Tel.: toll free (888) 303-3278
www.fab-form.com



Example of good foundation design. Moisture is kept away from foundation, membrane keeps water from the concrete.

Preventing Rising Damp

Isolate the concrete from any water source

Attach a dampproof or waterproof membrane to the outside. A vertical drainage layer can be added to provide a pathway for the water to the drain tile.

Concrete Wall

For impermeable subsoils such as clay or rock, a 3" to 4" granular drainage layer must be placed under the footing to create a capillary break and provide a water pathway to the adjacent drain tile. Permeable subsoils such as gravel do not require a drainage layer under the footing.

Concrete Footing

Use a footing membrane. All joints should be lapped a minimum of 8", and the bottom edge of the wall membrane must be lapped over the footing membrane to ensure that water is directed away from the footing and into the drainage layer below. The inside footing member should be cut away to provide an exit for any water that may enter.

Putting Mould-Related Health Problems in Perspective

Mould has been the subject much recent media attention, having moved beyond being an issue for homeowners, engineers and building maintenance personnel. Mould-related litigation has increased by 300% in the US since 1999. It seems that everyone involved with buildings is being sued. However, the vast majority of the cases are in the state of Texas.

Unfortunately, the profile this subject has received is the result of much bad reporting based on junk science and poor information.

The high profile Ballard court judgement in Texas, which fuelled the media frenzy, had nothing to do with health since all evidence related to health was excluded. The $32 million judgement was about bad faith on the part of the insurers, and the award was reduced by the judge mostly to the cost of repairs to the building. The punitive damages were reduced by an appeal court although this too is under appeal.

Indoor moulds such as *Stachybotrys chartarum* (also known as *Stachybotrys atra*) never cause infections and this has been clear for hundreds of years. Moulds may cause health symptoms that are non-specific, and need to be treated with respect. Current evidence indicates that allergies are most often associated with moulds.

Many credible health organizations including Health Canada, the California Department of Health, the Institute of Medicine of the US National Academy of Sciences, the US EPA, and the American Industrial Hygiene Association say that mould causes building-associated asthma. It exacerbates asthma in mould-sensitive asthmatics and can increase rates of upper respiratory disease. They also say that other rare consequences from high exposures to mould cannot yet be excluded. However, at present there is no test that proves an association between any specific species of mould and a particular health symptom.

Stachybotrys chartarum is a greenish-black mould that can grow on material with a high cellulose and low nitrogen content, such as fiberboard, gypsum board, paper, dust, and lint. Growth occurs when there is moisture from water damage, excessive humidity, water leaks, condensation, water infiltration, or flooding. Constant moisture is required for its growth.

Generally, it is not necessary to identify the species of mould growing in a residence. Since the susceptibility of individuals can vary greatly either because of the amount or type of mould, sampling and culturing are not reliable in determining an individual's health risk. Any person susceptible to mould will be at risk if mould is seen or smelled. Thus, no matter what type of mould is present, it should be removed. Individuals with persistent symptoms should see their physician.

In California, the State has passed legislation on mould in buildings that requires disclosure of a mould and a dampness problem upon sale and identifies mould as an occupational hazard. The mould must be removed by methods endorsed by the EPA.

Reliable sampling for mould can be expensive, and standards for judging what is an acceptable or tolerable quantity of mould have not been established. The US Centre for Disease Control does not recommend routine sampling for moulds.

If you decide to pay for environmental sampling for moulds, before the work starts, you should ask the consultants who will do the work to establish criteria for interpreting the sampling results. The consultants should tell you in advance what they will do or what recommendations they will make based on the results. The results of samples taken in your unique situation cannot be interpreted without a physical inspection of the contaminated area or without considering the building's characteristics and the factors that led to the present condition. ☼

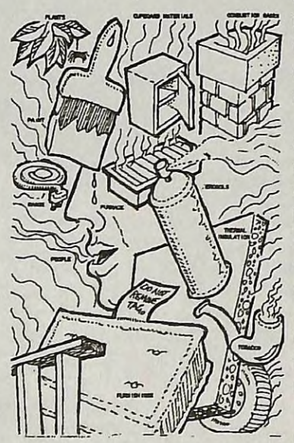
You Asked US:

about Volatile Organic Compounds (VOCs) and Indoor Air Contamination

My friend is having a problem with the new estate home he has just built. He and his wife have been forced to move out of their new home due to his wife's sensitivity to the VOCs being released in it. Is there any way to accelerate getting rid of the VOCs?

Over the years there have been many suggested solutions to this type of problem, but they generally don't solve it. There is no easy way to accelerate getting rid of VOC emissions. Although the emissions do eventually taper off, a source remains a source over a long period of time. How fast and how significantly the emissions decrease depends on their source.

Efforts have been made to hyperventilate new buildings to accelerate the venting of emissions of concern. High ventilation rates have been combined with heating to "bake out" the contaminants. However, the effectiveness of such strategies really depends on the source of the offending emissions.



Assuming that venting can take care of a good portion of the VOCs, it is important to realize that other materials (especially drywall) can be absorbers, and so become new sources of contaminants for a long time. That is why you can still smell cigarette smoke in restaurants and bars even after they have gone no-smoking. Accelerated ventilation may be useful if the sources are relatively small and mainly the result of site applied liquid finishes that need to be cured.

The best solution to deal with VOC emissions is to try and identify the sources of offensive contaminants, then have them removed or encapsulated. This includes any synthetic materials. Vinyl products such as vinyl cushion floors and vinyl wallpapers are one common source. Others may be various plastics used in the home, such as in decorative trims.

However, when the offending materials include kitchen and bath cabinets, particleboard closet shelving, thin wall panelling (all of which contain formaldehyde), encapsulating doesn't work well, and replacement can be expensive. If a new carpet is a strong source of VOCs, you should probably replace it.

Other problems could be minor back drafting or spillage of combustion gases, or air-pressure differences that pull air from a crawl space or garage.

Something else to keep in mind is that once someone has become sensitive, he or she starts reacting to lower levels of VOCs. If the source is removed or encapsulated, you may significantly reduce the levels of the VOCs, but the new lower levels may still be a problem for the person originally affected. Unfortunately, there are more than a couple of cases where people have done all of the above, then still have had to sell their house and relocate.

An excellent reference book is CMHC's ***Building Materials for the Environmentally Hypersensitive***, which provides a lot of information about properties of various materials and may help identify products that could be of concern.

Another good reference book is ***The Healthy House*** by John Bower (available from The Healthy House Institute (*www.hhinst.com*). ☼

Hydronics Professionals Certification

The Canadian Hydronics Council (CHC) recently confirmed the certification requirements for water heating systems professionals. It is expected that this will be the only hydronics certification recognized by inspectors and code officials across Canada.

Hydronics professional certification will be based on successful completion of CHC endorsed training programs delivered at community colleges across Canada; proof of valid experience requirements and/or trades qualifications; and continuing professional education. Hydronics professionals will be able to choose either the *Hydronics Installer* or *Hydronics Designer* certifications depending upon their interest and expertise. In the future, it is anticipated that only CHC-certified individuals will be able to design or install hydronic -heating systems.

Certification is the next step in a process that began with the development of the CSA B214 Installation Code for Hydronic Heating Systems. The British Columbia Institute of Technology (BCIT) and Northern Alberta Institute of

Continued on page 19

Energy Efficiency of Small Motors

Small motors are used in many residential heating and ventilation systems to drive air handlers in furnaces, fan-coils and ventilation systems. The most commonly used motors are shaded pole and permanent split capacitor motors. Increasingly, fans are operated continuously to provide ventilation and better comfort. However, continuously running fans become noticeable on the electric bill, so their efficiency is important.

The shaded pole motor is used in applications such as range-hoods, bathroom fans, furnace draft inducers, and some energy recovery ventilators. These motors are inexpensive but have low efficiencies, typically about 20 to 25%.

Permanent split capacitor (PSC) motors are used in furnace blower applications. The most common configuration is a direct drive where the motor is coupled directly to a fan wheel and placed in the airstream that passes over the motor, cooling it down. Peak efficiencies for these motors can approach 70%.

PSC motors are often considered as "high-efficiency" motors, although their true operating efficiency may not be much better than shaded pole motors at their operating conditions. PSC motors do not have the flexibility to go to lower speeds, and efficiency drops as speed is reduced. The PSC motor is typically set at half speed for ventilation purposes. If this speed is higher than required for continuous circulation, which is usually the case, energy is wasted due to both the higher speed and motor inefficiency.

Over the past decade manufacturers have developed several high-efficiency, alternative fractional horsepower motors. The most common types are known as electronically commutated motors (ECM), variable frequency induction motors, and electronically frequency modulated motors (EFM).

Electronically commutated motors are brushless, permanent magnet DC motors with integrated controls. They are significantly more efficient than the PSC motors used in most residential furnaces today and maintain good efficiency over all speeds in the design range. The efficiency improvement is especially noticeable when used in systems with continuous fan operation.

Unlike a conventional induction motor, the electronically commutated motor regulates itself by automatically changing torque and speed to maintain a programmed level of constant airflow over a wide range of external static pressures. The motor's control is programmed with a set of desired airflows (e.g., 800 cfm). As long as the pressure remains constant, the ECM will continue to deliver the preset 800 cfm to the system. If static pressure changes, for example a clogged air filter that restricts airflow, then the blower speed will increase. This is not unlike a car's wheels losing traction on ice and spinning freely.

Furnace blower versions are available in ⅛, ½, and 1 HP ratings and are generally designed for operation over the nominal speed range of 400 to 1400 rpm

Tests evaluating the impact of ECM motors on electrical and gas energy use on a home were done at the Canadian Centre for Housing Technology (CCHT) in Ottawa. The purpose was not only to demonstrate the ability of the high efficiency ECM technology to save electrical energy in moving air in forced air heating systems, but also to quantify the amount of any extra natural gas that would be required during the heating system in a climate that is typical of the Canadian winter heating season.

At low speed, a typical PSC furnace fan motor will use 350 to 500 Watts while an ECM will use only 75 to 125 W at a comparable speed. It was found that over an entire heating season, the electrical savings are more than 1000 kWh/year when the furnace is running continuously. This is equivalent to greenhouse gas reductions of more than 900 kg/year of CO_2. However, the decrease in electrical consumption increases the natural gas consumption since much of the electricity used by the less efficient motor ends up as space heat, while the more efficient motor produces less heat. The increased gas consumption to compensate for the excess heat generated by conventional motors is about 100 m^3/year or 5% of annual consumption.

If the house is air conditioned, then the same heat balancing requirement will reduce the amount of electrical energy used by the air conditioner with an ECM, resulting in even more savings. The impact of electronically

commutated motor use on air conditioning cooling loads is still being analyzed. The lower energy use by the motors should reduce overheating in the house.

Compared with basic models, most furnaces that use energy-efficient motors tends to be high-end products that incorporate additional features like multi-stage gas valves. Prices for furnaces with and without efficient motors are difficult to obtain easily, but the incremental cost of an electronically commutated motor itself is about $400 to $800. ☼

Incentives for Home Energy Upgrades

A program to encourage home energy efficiency upgrades is now underway. Unlike past insulation upgrades, a third-party audit process is in place to ensure that effective upgrades are undertaken. The gauge of improvements made is based on an **EnerGuide for Houses** evaluation done before and after the upgrades.

The EnerGuide for Houses Program was developed to:

- address Canada's climate change goals by reducing greenhouse gas emissions from the housing sector;
- foster the development of energy efficiency expertise in the Canadian housing industry; and
- provide Canadian homeowners with reliable energy efficiency information to help them make informed choices when retrofitting/ renovating their homes.

The program is delivered as an expert advice service for homeowners. Qualified auditors make house visits to do a detailed assessment of a home's energy use characteristics and to produce a retrofit assessment with energy upgrade recommendations. After the energy efficiency upgrades have been completed, a post-retrofit evaluation is done to provide an upgraded rating label for the home.

Not all energy upgrades generate the same energy savings. For example, there will be more energy savings by replacing an old furnace with an energy-efficient ENERGY STAR qualified furnace than by upgrading a home's windows.

The rating of an average Canadian home is 62 on the EnerGuide for Houses scale and has the potential to improve to a rating of 73. An R-2000 home rates 80 on the scale.

The size of the incentive grant will depend on the difference between the EnerGuide for Houses ratings of the home before energy efficiency retrofits are made and after they have been completed. There are no specific energy efficiency retrofits that "qualify" for the grant. Rather, it is based solely on the difference in the EnerGuide for Houses ratings before and after the energy efficiency retrofits. The greater the improvement in the energy efficiency rating, the larger the grant. For example, improving a home's rating from 62 to 73 could result in a grant of about $619.

The EnerGuide for Houses evaluation report will identify which retrofits are most suitable for a specific house. The service has been designed to make recommendations for reducing a home's energy use, and most efficient use of energy, so it does not favour one energy source over another. Energy switching in itself will not qualify for a grant.

A list of delivery agents authorized to perform the EnerGuide evaluations is available at NRCan's Web site:

energuideforhouses.gc.ca/agent
http://oee.nrcan.gc.ca/houses-maisons/
or toll free at 1-800-387-2000

Energuide for Houses Ratings

Typical Rating	House Characteristics
0 to 50	old house not upgraded
51 to 65	upgraded old house
66 to 75	typical new house or energy efficient upgraded old house
68 to 79	energy efficient new house
80 to 90	Highly energy efficient new house (R-2000 houses are a minimum of 80)
91 to 100	houses that approach zero purchased energy

Technical Research Committee News

Canadian Home Builders' Association

Crawlspaces and Indoor Air Quality

A number of unheated crawlspaces with high levels of mould growth have recently been observed in New Brunswick. A detailed inspection of one house showed that the building met the strict requirements of the National Building Code. It had a moisture barrier on the ground that was covered with sand for protection, damp proofed foundation walls and an adequate venting area provided by operable basement windows.

This problem arises from time to time and seems to be caused by a number of variables: homeowner misunderstanding of how to manage crawlspace ventilation, poor moisture barrier installation, a high water table, climate factors and factors affecting the rate of natural ventilation.

Even though the NBC allows unheated crawlspaces, it is recommended that builders avoid these variables by building insulated, heated crawlspace foundations. The key to avoiding moisture and moisture-related problems in foundations is to remember that ground water moisture management around the foundation is important.

Furnaces in New Construction

The long process of making changes to the furnace standard to address construction heat is approaching a conclusion. All levels of the standards process, including provincial regulatory authorities, have approved the revised furnace standard that will include new wording to allow the use of furnaces to provide temporary heat during construction. The effective date for the new requirements is set for April 1, 2005.

Beam Calculator

The Canadian Wood Council is developing a beam calculator that will be available on its Web site (www.cwc.ca). The calculator will allow users to quickly and easily determine the proper span of wood products in applications such as headers, lintels, ridge beams and main beams. Users will enter loads and span and which type of wood product to use. Product selection will include built-up beams with 2x, 3x, 4x lumber, glulam or heavy timber of Canadian species.

Storage and Handling of Lumber

The Canadian Wood Council is developing a publication that will cover proper storage and handling of lumber on a construction site. The publication will provide technical information on how wood responds to the environment and how wood can be protected to maintain it in a condition so that it performs as expected.

However, many builders complain that lumber dealers often are not handling lumber properly, so that it arrives on a job site with inadequate protection and with excessively high moisture content. Builders are encouraged not to accept deliveries of materials that have been improperly handled. They should also contact the manufacturers to advise them of their concerns, since the lumber industry has standards that cover lumber product handling.

Front Loading Washers

The drive to improve energy and water efficiencies means that more people are taking advantage of front loading washing machines. These have been the standard in Europe, and are now gaining popularity in North America. American manufacturers are now beginning to make such equipment as well. The attraction of these units is that they use very little water and, because of their fast spin cycles, reduce the water content remaining in the laundry after spin drying, thus reducing drying times.

The fast spin cycles have also generated some complaints, and raise the possibility that these units may not be well-suited to standard wood frame floors. It seems that during the spin cycle the equipment can set up harmonic reactions with the structure, leading to noise and vibration. These problems are less apparent where the units are placed on a concrete floor slab because of the stiffness of the structure. In Europe most homes are stiffer masonry structures, while in Canada we use wood framing, which is a softer, more flexible material.

If anyone has experienced noise problems with horizontal axis, front loading washing machines, let us know. It will help identify the magnitude of the problems, and help a research initiative investigate the issues.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

Canadian Home Builders' Association,
Suite 500, 150 Laurier Ave. West, Ottawa, Ont. K1P 5J4
Tel: (613) 230-3060
Fax: (613) 232-8214
e-mail: chba@chba.ca
www.chba.ca

Impact of an Electronic Air Cleaner on Indoor Ozone Levels

One out of every four new homes built in Canada has an electronic air cleaner. It is also a popular option for homeowners who upgrade or improve their central forced air heating and ventilation systems. Electronic air cleaners have been used in homes for at least 20 years and are sold on the basis of their potential to relieve the symptoms of sufferers of allergy-related and respiratory conditions by reducing indoor airborne dust levels. However, these devices may raise indoor ozone levels and cause subsequent negative health impacts. Some house dust mite allergic-asthmatic persons are more sensitive to ozone than non-asthmatic non-allergic persons.

Plate and wire type electronic air cleaners (also called electrostatic precipitators) are typically used with central forced warm air heating systems. Although electronic air cleaners are excellent filters, especially for fine particles, they do produce ozone during operation.

Ozone is a known respiratory irritant. Current public health practice is to declare "bad air days" when outdoor ozone levels are expected to exceed 82 ppb for one hour. Persons with respiratory challenges are advised to remain indoors and to keep windows and doors closed. This is based on the assumption that the exposure of persons indoors is considered to be a function of the outdoor ozone level and the sheltering effect of the building. The effects of ozone on population health are seen at much lower ambient concentrations.

The current Health Canada exposure guidelines for residential indoor air quality for ozone are set at 120 ppb for a one hour exposure, but other standards set substantially lower limits. The US Food and Drug Administration standard is 50 ppb maximum, not to be exceeded at any time. Research papers have identified respiratory symptoms beginning at ozone levels of 80 ppb. Reduced lung function in healthy children has been suggested for concentrations as low a 60 ppb.

Recent studies have found that winter indoor ozone levels tend to be higher in homes that are equipped with an electronic air cleaner compared with homes that do not have one. Although outdoor ozone remains the most significant determinant of indoor ozone, the continuous operation of an electronic air cleaner can increase indoor ozone concentrations by about 10 ppb higher than that which would normally be expected without an electronic air cleaner in operation. The manufacturer of an electronic cleaner unit tested states that their unit can be expected to add 5 ppb to the steady state indoor level of ozone in a house.

Ozone concentration increases can be higher than this for smaller homes and homes with more smooth surfaces (e.g., smooth floors compared to carpeted). The increase will be lower for a larger home with fewer smooth surfaces.

Changes in airflow through the electronic air cleaner don't have a big effect on ozone levels. Reducing the airflow by 50% resulted in an increase of ozone production and interior levels of less than 10%. Production of ozone by an electronic air cleaner does not appear to be related to maintenance, or the cleaner's condition. It appears to be relatively constant, as long as the unit is working.

Current knowledge does not allow us to state definitively that the health of susceptible individuals will not be affected.

Electronic air cleaning devices are promoted by their manufacturers as having the beneficial health effects for persons with respiratory conditions such as house dust mite allergic asthma. Ozone is known to worsen the symptoms of persons with these types of allergies, and they are often advised to convert carpeted floors to smooth finishes. Thus, it is possible that the combination of ozone creation by an electronic air cleaner and the reduction of reactive surfaces will result in ozone levels which exacerbate the symptoms of an allergic asthmatic person, reducing any benefit that the air cleaner may have by way of reduction of house dust mite allergens.☼

Influence of an Electronic Air Cleaner on Indoor Ozone *by Dara Bowser, Bowser Technical Inc. for CMHC Research Division*

Penetration of Outdoor Particles into a Residence

We are increasingly concerned about the indoor air quality in our home and work environments. Fine particles we can inhale are one contaminant that can have a negative effect on our health. Fine particles such as wood smoke and particulate from vehicles and industrial sources are generated outdoors. We want to keep these outside, but the smallest particles can penetrate into a home even when the doors and windows are closed.

Dust levels are measured at outdoor atmospheric sampling stations. However, most North Americans spend 90% or more of their time indoors. Up to now, indoor particulate levels have been estimated as a ratio of indoor to outdoor concentrations. There has been little study done on how a home's operation can affect indoor dust levels.

Outdoor air enters a house through intentional air inlets or through the building envelope, so the envelope itself could be a filter for the incoming air.

A recent CMHC study set out to determine how filtration and ventilation systems can affect the indoor-outdoor ratio of fine particle concentrations in a home. It also looked at the impact of filtration of the incoming air through filters and the house envelope itself.

Air tests were done at one house in Brantford, Ontario, during spring and summer when it was operated under five different ventilation modes:

- Supply Only, No Filtration
- Exhaust Only, No Filtration
- Balanced, No Filtration
- Balanced, with HEPA Intake Filter
- Supply Only, with HEPA Intake Filter

Ventilation rates for the test ranged between 0.71 and 1.20 air changes per hour (much higher than typical operating conditions) and were selected to ensure that for the supply only arrangements, all of the incoming air passed though the ventilation system. In the case of the exhaust only arrangement, all of the incoming air passed though the building envelope.

In general, it was found that filtering the incoming ventilation air resulted in significantly lower indoor particle levels than outdoors. The non-filtered ventilation arrangements resulted in higher levels of indoor particles compared with outdoor levels.

Exhaust Only ventilation arrangements (where the incoming air is filtered by the house envelope) resulted in ratios in the mid-range between the filtered and unfiltered ventilation cases. An exhaust-only type of system provides some protection from outdoor particles because of the filtering action of the building assemblies, which appears to give a significant degree of filtration.

Supply Only with a filter. The indoor particle levels are essentially independent of the outdoor levels, showing small peaks in the morning and evening related to occupant activity.

Supply Only with no filtration. Bringing unfiltered outdoor air directly into a home through an open, unfiltered intake allows outdoor particles to penetrate directly into the home. The indoor particle levels are influenced mostly by the outdoor particle levels. The occupants have a relatively minor impact.

If outdoor air is introduced to the house via an intake duct to the central air handler or furnace, the filtration of outdoor air particles will only be as good as the filter in the air handler. If outdoor air is introduced by means of a central ventilator such as an HRV, outdoor fine particles will enter the home easily unless an effective filter is included in the system. A balanced ventilation system (such as HRV) can provide performance which approaches that of the filtered supply-only system, even for a house which is only moderately air-tight.

The best protection from outdoor particles is provided by a system that positively pressurizes the house while cleaning the incoming air with a high-efficiency filter. The main drawback of his type of system is the tendency to introduce moisture into the building envelope assemblies during the winter.☼

Penetration of Outdoor Particles into a Residence *prepared by Dara Bowser for CMHC Research Division*

Cooling Rates of Houses During Extended Power Failures

Better insulated, more airtight homes with good solar orientation will remain warmer than houses with low insulation levels and no solar gains.

Many Canadians wonder, if they leave their homes for extended periods of time in winter and there should be a power outage, how long would their houses stay warm? In most cases, houses will stay above the freezing point for much longer than expected. If the power fails during winter, a house may take days or weeks to fall below freezing, depending on the severity of the weather outside, if the house freezes at all.

The need to protect water systems, valuable furniture, pets or plants can be met over several days, rather than several hours. House temperatures will drop quite quickly to levels that could be uncomfortable (or dangerous for sensitive occupants), but the house itself may take many days to drop to freezing temperatures.

If the furnace stops working, the house will start to cool immediately. The colder it is outside and the higher the indoor air temperature, the faster the rate of cooling. Assuming that the indoor temperature is about 20°C, in the first several hours or overnight the indoor air temperature can drop to 14°C or 15°C. This is about the same as happens in a home with a setback thermostat that has been programmed to those settings. From that point on though, cooling occurs more slowly. Part of this is because as the indoor temperature drops, the differential of indoor to outdoor temperature becomes lower, and part is due to the thermal mass of the house.

While the air may cool quickly, the materials from which the house has been built – concrete, wood, ceramics, gypsum, and furnishings – will take longer to give up the heat they've stored. As well, in most houses with basements or crawl spaces, the earth beneath and around the house has a high thermal mass and does not change temperature very quickly. If the soil temperatures are at 5-10°C, they rarely drop below this except near the surface, where the temperatures are more directly influenced by outdoor conditions.

A third factor is the heat gains from the sun and occupants in winter. The coldest weather is usually associated with clear sunny days, so reasonable areas of south-facing glass that are unobstructed will ensure that solar heat will increase the home's interior temperature during the day. The structure and furnishings will absorb the heat to store it for the night when temperatures drop.

Some of the best information on house cooling rates has come from the ice storm in Eastern Canada in January 1998. House temperatures in 31 houses were measured in the Saint-Jean-sur-Richelieu region of Quebec, 12 to17 days after the power failed.

The houses represented a wide range of size, type (bungalow, two-storey, small multifamily), and age (built from 1910 to1994). The mean outside temperature during this period was between -7°C and -8°C, with daytime highs of up to 3°C. This was warmer than usual for midwinter conditions in this area but still significantly cold. The temperature also dipped to as low as -23°C during this period.

None of the air or surface temperatures inside the 31 houses fell below 0°C. Typically, basement air temperatures averaged 7.4°C, while first floor temperatures were slightly lower. If the outdoor temperatures were colder and the weather windier, cooling would have been greater, and temperatures inside would also have been lower. The severity of the temperature drop depends on the house design and construction details. ☼

Cooling Rates of Houses During Extended Power Failures
CMHC Research Division

Energy Answers

What is the status of solar energy use for new houses?

Rob Dumont

Here are a few points that are of interest:

1. The sun provides the earth with about 10,000 times as much annual energy as do all the other sources of energy currently being used (coal, oil, gas, propane, nuclear).

2. Virtually all homes on this planet are already more than 95% solar heated.

How can one make such an audacious statement? The earth would be at a temperature of -273°C without the sun. The average annual temperature in the populated areas of Canada is about +7°C, and our furnaces, boilers, etc. only need to top up the temperature in houses to about +22 °C. If you do the math, an average Canadian home has its temperature raised about 95% by the action of the sun; all a 100% solar heated home has to do is raise the temperature that last 5%.

3. A very large amount of solar energy strikes the roof of an average house. At about 5 gigajoules (GJ) per square metre per year in most parts of southern Canada, the sun striking a house with a roof area of 100 square metres amounts to 500 GJ per year.

The average Canadian house uses roughly 150 GJ of energy per year for space heating, water heating, lights and appliances.

4. Passive solar energy can provide a substantial part of the space heating in a house. For instance, in the house my wife and I own, about 35% of the annual heating load is covered by passive solar energy, primarily through south facing windows. Careful design of a passive heating system is needed to prevent overheating in the spring, summer and fall. Appropriate window types, window areas, internal thermal mass and shading are needed to get a satisfactory passive solar fraction in a house without overheating.

5. Daylighting is another major aspect of solar energy use in homes. Without daylighting

Technology	Capital Cost	Comments
1. Solar energy striking the earth's surface	Nothing	All of our existing fossil fuels - coal, oil, gas - were provided by solar energy through photosynthesis.
2. Passive solar heating	Nothing to several thousands of dollars	Orientation of the house for passive solar gain, appropriate window types, window areas, internal thermal mass and shading are all needed to make the best use of passive solar.
3. Daylighting	Nothing	Proper window orientation and sizing is important to make the best use of daylighting.
4. Solar domestic water heating systems	$4500 is the approximate installed capital cost for a 6 square metre flat plate system.	Well-installed systems can provide about 2 GJ per square metre per year in southern Canada. At an electricity cost of $0.10 per kWh, a 6 square metre system supplying 2 GJ/ m2 would provide about $330 a year of useful energy.
5. Active solar space heating systems	Cost varies with system size and complexity, but the useful energy output is reduced compared with a solar water heating system because the heating season in a well-designed house in Canada is usually less than 7 or 8 months per year.	Assuming a system could be installed for $10,000 and could provide 1 GJ/m2 per year from a 12 square metre system, the useful annual energy collected would equal about $660 assuming electricity at a cost of $0.10 per kilowatt-hour is being displaced.
6. Solar photovoltaic systems	Cost varies with system size and complexity, but the annual cost of electricity is in the range of about $0.50 to $1.00 per kilowatt-hour when the system is amortized over the life of a mortgage.	A 2 kilowatt peak output system with a grid connect in most parts of southern Canada would produce about 2000 kWh per year. The capital cost for such a system would likely be in the $20,000 + range.

we would have to use artificial lighting 24 hours a day.

6. Solar water heating systems, usually with flat plate collectors, are now in wide use in some parts of the world with high energy prices. By law all new homes in Israel must have a solar water heater. Water heating is particularly attractive because the hot water is useful on virtually every day of the year. Thermosyphon systems are the most common systems worldwide, and are particularly clever devices because no pumps or thermostats are required. Unfortunately, these simpler systems have not been used much in North America.

7. Active solar space heating systems have been used in houses, although to a much lower degree than solar water heating.

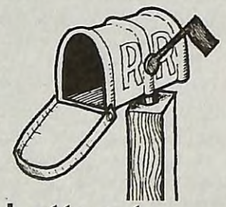
8. Solar photovoltaic panels are now being used in increasing numbers. Assisted by government programs, thousands of houses in Japan and Germany are now providing for a substantial part of their electricity needs with PV panels.

The table summarizes the costs of several solar energy technologies for houses. As can be seen from the table, passive solar heating and daylighting are the most cost-effective solar energy applications.

A solar water heater is now relatively cost competitive with other long-term investments in those parts of Canada with higher energy prices. As the volume production of solar water heaters increases, the cost will likely come down.

Active solar space heating and solar photovoltaic systems have higher costs, but cost reductions are quite likely with higher production volume, particularly with photovoltaic systems. According to a recent paper by André Filion, Deputy Director of the CANMET Energy Technology Centre in Varennes, Quebec, the annual global production of solar cells has risen by a factor of seven in the period from 1991 to 2001.

Prior to 1973 and the first world oil crisis, conscious use of solar energy in houses was almost unknown. The solar technologies now at least have a beachhead. ☼



Letter to the Editor

Re: Thermal Mass and Energy Use, (Solplan Review No.111, July 2003)

The Portland Cement Association study presented some interesting information about how masonry walls compare with wood frame walls. Unfortunately, the benefits of the thermal mass of the masonry are observed by the variability of the wall construction under review. Yes, the ICF wall looked much better than the frame wall, but maybe that was because of the higher R-value of the ICF wall, not its thermal mass. Add enough insulating sheathing to the frame wall to give an equivalent R-value, then compare the two.

Contrary to expectation, why did the cast-in-place wall with the exterior insulation do more poorly than the wall with interior insulation? Probably because the first had a lower R-value; or maybe because it had lower thermal mass? I would like to put the insulation on the exterior of the thermal mass, but this study didn't give the right comparison – namely, same R-value, same mass for both walls – to justify this.

Two of the wall systems did have equal R-values and mass – the sandwich panel and exterior insulated concrete wall. The superior performance of the sandwich panel showed that it's better to place at least some of the thermal mass on the interior of the wall. Another pair of walls with equal R-values (the wood frame wall compared with a similar wall inside a concrete block) suggested that even in Canadian climates, the masonry wall required less heating and cooling energy. But the relative advantage decreased the colder the climate, as you noted in the article.

So all in all, an interesting comparison, but still inconclusive.

Richard Lay,
Waterloo, ON

NRC·CNRC

Durability and Performance of Wall Assemblies

This article reviews some key issues in the assessment of the long-term performance of wall assemblies.

by Michael A. Lacasse

The performance of a wall assembly depends on the performance of individual components. Thus it is essential to ensure continuity of the assembly especially where junctions and penetrations such as windows, ventilation ducts, electrical outlets, and pipes occur. Good long-term performance (durability) depends on providing functional details at these vulnerable points of the assembly.

Various methods can be used to assess the long-term performance of assemblies or components. When an estimate of performance is based on test results, one must always take into account the differences between the test conditions and the in-service conditions. Performance assessments of new and innovative products follow carefully designated test methods having a specified set of conditions so that meaningful and comparable results can be obtained.

Figure 1 shows a performance indicator (index) that diminishes over time for two types of components. The first (i) – for example, sealant deterioration in a joint serving to seal the interface between a window frame and the cladding – is characterized by a rapid rate of deterioration followed by maintenance to restore it to a higher level of expected 'performance.' The second (ii) might be the window itself, for which the rate of loss in performance (e.g., reduction in watertightness) is comparatively less pronounced.

There is a limit below which the performance of a component is no longer acceptable, in effect a "limit state." At this stage (state), the component should be replaced, or refurbished. An increased level of performance, close to but not that of the initial state, indicates replacement (or refurbishment). The on-going cycle of deterioration and refurbishment continues until the limit state is reached.

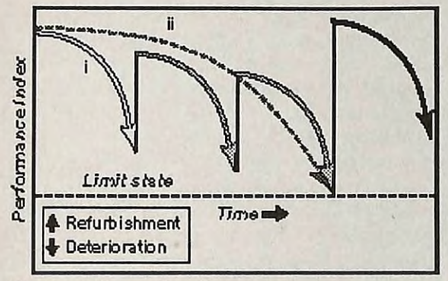


Figure 1. Loss of performance over time – effects of deterioration.

Characterization of Environmental Loads

Of the many agents of deterioration, moisture (atmospheric and rainfall) is a particularly important issue in assessing the long-term performance of wall assemblies. Temperature (T), atmospheric moisture (RH), wind (wind speed - v) and precipitation (rainfall intensity, RI) are the main factors affecting either the wetting or the drying of building elements, or both (Figure 2). Rainfall and wind characteristics provide a good indication of the wetting potential for a given location, while levels of atmospheric moisture affect the drying potential. Outdoor temperature, wind and atmospheric moisture are factors that can contribute to condensation on inside wall surfaces and inside walls.

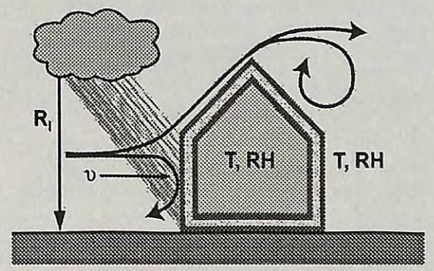


Figure 2. Effects of climate loads – wind brings about pressure differences across the wall directly related to wind speed (v). The rate of rain deposition on walls is related to the combined action of rainfall (RI) and the effects of wind.

The two key climatic considerations for assessing a wall assembly's ability to manage rainwater and control rain penetration are the wetting potential due to rain and the drying potential due to atmospheric moisture. The wetting potential for a location can be estimated from the annual average rainfall. Knowing the

Dr. Michael Lacasse is a senior research officer in the Building Envelope Program of the National Research Council's Institute for Research in Construction. He can be reached at: Michael.Lacasse@nrc-cnrc.gc.ca

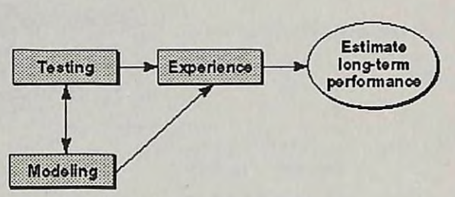


Figure 3. Interrelation between long-term performance assessment, testing, modelling and field experience.

intensity, duration and frequency of rainfall provides a more select measure of rainwater load. Rainfall typically does not occur, or very seldom occurs, without wind, so the effect of wind-driven rain on the cladding must be considered. As may be expected, coastal and maritime climates have noticeably higher wetting potential compared to other regions in Canada. As well, the ability of walls to dry in coastal and northern regions is low compared to that in warmer and drier regions of Canada.

Assessing performance

The long-term performance of building components and assemblies can be assessed in different ways. As provided in the CSA Guideline on Durability in Buildings, an estimate of long-term performance (service life) can be based on demonstrated performance (experience), performance testing, or the analysis of results from modelling.

Testing

The testing of wall cladding and assemblies includes conformance evaluations, as are prescribed by IRC's Canadian Construction Materials Centre (CCMC) for new or innovative products. For example, windows must meet the performance requirements for heat loss, air leakage, water penetration and structural strength according to CSA 440. The watertightness of wall assemblies and cladding systems is assessed using ASTM E331. Similarly, there are standard tests to determine the level of performance of most elements of the building envelope.

Performance testing establishes the degree to which a component or assembly conforms to a level of acceptable performance. It also helps to determine the location of vulnerable points in a wall assembly, the test loads at which anomalies occur, and possibly, to relate the response of the test specimen to specific details or simulated climate effects.

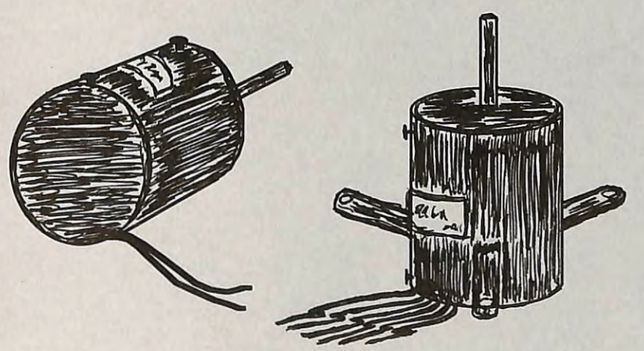
Estimating the long-term performance for new or innovative products is challenging since it is necessary to obtain results in a time frame much shorter than the expected life of the product. As well, there is a need for test results to provide some measure of adequate performance or risk of premature failure. Understanding the behaviour of component parts of an assembly in relation to the performance of the system is a primary concern when developing performance assessments. This is achieved by assessing products on the basis of how they will be used in practice. In this manner, interfaces of adjacent products are delineated, details defined, and in-service conditions estimated. On the basis of results, key elements ensuring long-term performance are recognized.

Performance testing incorporating accelerated techniques can be used when the in-use conditions are known, mechanisms of deterioration are understood, key effects causing deterioration have been identified, and the range of effects (application time and severity) can be adequately simulated in the laboratory. As well, effects applied to a test product should not bring about changes in the product that are unlikely to occur in service. Hence, for accelerated tests to have validity, there must be a reasonable relation between it and the service environment.

Modelling

Advanced hygrothermal models, such as those developed by IRC, simulate the performance of wall assemblies. They can be used to determine the changes in moisture content, relative humidity and temperature in any wall component when subjected to simulated climate loads. Over the course of a simulation, the hygrothermal response to simulated environmental loads on either side of the wall is known; models can trace the moisture content, relative humidity and temperature in each of the elements within each layer of the wall for every hour being simulated. Materials that reach high moisture content, high temperature or both conditions simultaneously can readily be identified. Modelling the response of the wall to the action of climatic loads provides a means for recognizing elements that remain 'too wet' for 'too long.'

Modelling can extend the results obtained from full-scale laboratory performance tests. The performance response of many different variations in wall assembly can be simulated. Modelling also permits identifying vulnerable materials and key components, and isolating the basic variables affecting the performance of components.☼



Continued from page 8

Technology (NAIT) have developed curricula based on the standard and are ready to launch their CHC endorsed programs via correspondence, Web or traditional classroom-based formats.

The Hydronics Design Standard Committee that developed the program is a national group that draws technical expertise from the Alberta Hydronics Advisory Committee, the Residential Hot Water Heating Association of British Columbia, BCIT, NAIT and CHC.

For more information
Canadian Institute of Plumbing and Heating
Tel.: (416) 695-0447
Fax: (416) 695-0450
www.ciph.com

SOLPLAN REVIEW is an independent Canadian Journal published 6 times per year to serve the needs of professionals and interested lay persons. It provides news, technical details, new product information, insights and commentary on developments covering all aspects of building science and energy efficient building practice for new and retrofit residential construction. Technical information is presented in a clear, concise manner, without resorting to jargon.

SOLPLAN REVIEW is an independent subscription supported publication, that relies on the support of readers. *If you are seeing this journal for the first time, and find it valuable, why not ensure you don't miss any copies. Subscribe today!*

YES, I WANT TO SUBSCRIBE TO **SOLPLAN REVIEW**

In Canada: 1 year: $50.29 ($47.00 + 3.29 GST) [NB, NS, NF $54.05 includes HST]
2 years: 90.95 ($85.00 + 5.95 GST) [NB, NS, NF $97.75 includes HST]

USA and other foreign: 1 year $54.00 per year 2 years: $98.00 (USA and other foreign in US funds)

Pay by: VISA MASTERCARD CHEQUE

Card No. _____ Exp. date: _____

Signature _____

NAME _____

ADDRESS _____

_____

POST CODE _____

the drawing-room graphics services ltd.
Box 86627 North Vancouver, B.C. V7L 4L2
FAX (604) 689-1841
e-mail: solplan@direct.ca